1988

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Introduction

Why an interest in twinning in cattle?

- More than one-half of the feed units used by the national beef herd are needed to meet *maintenance requirements* of the reproducing female population.
- The beef cow is capable of producing about *.7* of her body weight per year in progeny market weight.
- The sow is capable of producing more than *8* times her body weight per year in progeny market weight.
- The meat type hen is capable of producing more than *70* times her body weight per year in progeny market weight.
- The channel catfish female is capable of producing more than *1,000* times her body weight per year in progeny market weight.

Research objectives of this project are: (1) Determine the effectiveness of selection for multiple births in cattle and estimate genetic correlations between twinning rate and other bioeconomic traits; (2) develop selection criteria and procedures for multiple births in cattle; (3) accumulate data that will contribute to an economic assessment of multiple births in cattle for varying production resource situations; (4) establish nutritional and other managerial requirements for herds of cattle that have a high twinning frequency; (5) determine the relative importance of multiple ovulation and embryo survival in contributing to multiple births in cattle in both spring and fall breeding; and (6) determine the usefulness of cows with high twinning frequency as "models" to gain understanding of biological factors that relate to ovulation and embryo survival for both single and multiple births in cattle.

Procedure

About 50 females/year with highest estimated breeding value (EBV) are superovulated (25 in May and 25 in September). Embryos are collected and transferred into recipient females with low EBV. The intent is to produce from 125 to 150 progeny/yr from high EBV cows mated to high EBV bulls.

Barring the identification of a gene with a major effect on twinning frequency, we do not expect much progress *unless* an effective selection criterion is identified that can be used at an early age. Therefore, starting at puberty, ovaries of all heifers are palpated per rectum to determine ovulation rate (number of corpora lutea) for 6 to 9 mo (8 to 12 estrous cycles) and are bred first at about 19 mo of age. Palpation of fall-born heifers starts in July and continues until April, and, for spring-born heifers, palpation starts in March and continues until October. Fall-born females are bred in their second spring and spring-born females are bred in their second fall.

Females are palpated per rectum to determine ovulation rate during the artificial insemination (AI) breeding season (spring and fall). Multiple ovulating cows are paired with contemporary single ovulating cows, and both are laparoscoped to validate rectal palpation results. It is important to know the relative effects of ovulation rate and embryonic loss on twinning frequency. Embryonic migration between uterine horns seldom occurs in cattle. Therefore, the effect of bilateral and unilateral multiple ovulations on embryonic loss and twinning frequency is of considerable interest. Spring and fall breeding seasons are about 60 days; 40 days are by AI and 20 days are by natural service in individual sire breeding pastures. Calves are weaned at the end of the AI breeding period.

Cows in the twinning project are weighed and scored for condition five times each yr; i.e., (a) before calving, (b) before breeding, (c) end of AI breeding period, (d) end of breeding season, and (e) when palpated for pregnancy. Height at hooks is taken at each period except at the end of the AI period.

Heifers are weighed at birth, weaning (about 100 days), and about 200 days of age. They are weighed, measured, and scored at about 12 mo and again at end of ovulation rate evaluation cycle (about 19 mo) or when they go, as appropriate, to either (a) breeding, (b) donor use, or (c) recipient use.

All females in the twinning project are fed consistent with requirements to maintain them in optimal breeding condition. It is recognized that the nutritive requirements are affected by age, lactation status, number of nursing progeny, breed, etc. Thus, the nutritive environment is varied consistent with nutritive requirements.

Pelvic area on males and females in the twinning project is measured at 11 to 12 mo of age. Libido evaluations are taken on spring born males retained for breeding but not on fall born males. Males are weighed at birth, at weaning (about 100 days), at about 200 days, and are weighed, measured (including scrotal circumference), and scored at about 1 yr of age. Thereafter, weights, measures (including scrotal circumference), and scores are taken two times each yr (May and September) as long as bulls remain in the herd.

About 15% of the females with highest EBV for twinning are mated to proven sires (ovulation rate of daughters in 8 to 12 estrous cycles) to produce replacement bulls. About 20 to 25 young males with highest EBV for twinning are retained each year and mated to the females not bred to proven sires. The intent is to obtain 10 to 12 daughters by each young sire. Semen is collected and stored on each young sire. Ovulation rate of these daughters (8 to 12 estrous cycles) is the primary criterion for identification of bulls to use on high EBV females to sire males for the next generation. Progeny tests for ovulation rate are completed when sires are about 4 yr old. In order to control rate of inbreeding, a minimum of 6 males from the 20 to 25 young males selected and used each year are used subsequently in matings with highest EBV cows.

Matings are planned to limit the contribution of a single breed to 50% or less in any individual in early

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[2]The authors would like to acknowledge W. Gordon Hays, cattle operations manager, Steven M. Kappes, cattle operations assistant, and Darrell E. Light, statistical coordinator, for their assistance with this project.

generations and to 30% or less in the longer term. Breeds represented in the project are: (1) Holstein, (2) Simmental, (3) Charolais, (4) Brown Swiss, (5) Pinzgauer, (6) Gelbvieh, (7) Swedish Friesian, (8) Norwegian Red, (9) Shorthorn, (10) Hereford, and (11) Angus. Breeding (calving) occurs in both spring and fall.

Results

A total of 96 cows with records of two or more twin calvings were acquired from industry in 1976-77 (46), and in 1981-82 (50). Prior records averaged 3.83 parturitions per cow and 1.73 progeny per parturition. Subsequent records have averaged 2.47 parturitions per cow and 1.20 progeny per parturition. A total of 208 females with a record of twinning in other projects at the Research Center were transferred into the twinning project. Prior to transfer, these averaged 2.59 parturitions per cow and 1.39 progeny per parturition. Subsequently, they have averaged 2.92 parturitions and 1.15 progeny per parturition. Semen from three Swedish Friesian sires and two Norwegian Red sires whose daughters had produced twins at a high frequency was introduced in 1983 and in 1984, respectively.

Parturition records (1,194) were analyzed for 578 females born in the project from 316 dams and 51 sires. In this population, mean twinning rate was 8%; estimated heritability was .06 from paternal- and .07 from maternal half-sib correlations; and repeatability was .12. Twinning rate was 1.05, 1.08, 1.08, and 1.11 for 2-, 3-, 4- and 5 + year olds, respectively, and 1.06 *vs* 1.10 for spring *vs* fall calving.

Records (1,730) of ovulation rate were analyzed for 289 heifers, 12 to 20 mo of age, from 222 dams and 37 sires. These heifers averaged 6 cycles/heifer and 1.09 ovulations/cycle, with paternal half-sib heritability of .07 and repeatability of .07. Heritability of ovulation rate predicted for means of 6 and 10 estrus cycles/heifer from estimated heritability and repeatability of single-cycle data, was .31 and .43, respectively.

Precision of ovulation rate determination by rectal palpation in 330 postpartum cows was evaluated by laparoscopy with results as follows: Correctly identified 147 of 165 single ovulations (89%) and 125 of 165 multiple ovulations (76%).

Conception rate in postpartum cows was .58 (607 observations) and .67 (99 observations) with single and multiple ovulations, respectively. Embryonic survival was .58 (607 observations) and .49 (205 observations) for single and multiple ovulations, respectively. Embryonic survival was .55 (93 observations) and .44 (112 observations) for bilateral and unilateral multiple ovulations, respectively.

Ovulation rate in yearling females for 8 to 12 estrous cycles appears to offer a useful selection criterion for identifying replacements and for selection among bulls based on progeny test of 8 to 12 daughter progeny per sire.

Differences between singles (2,537) and twins (438) were important for calf survival ($P < .01$); i.e., survival to 72 hr was .96 and .78 and to weaning was .91 and .72 for singles and twins, respectively.